

CLAIMS

5 *Sub C2*

1. A filter assembly comprising a plastics housing (10) providing an inlet port (16) and an outlet port (31), the material of the housing (10) being such that the assembly can be sterilized by subjecting the interior of the housing (10) to steam under pressure while the exterior of the housing (10) is at atmospheric pressure without damaging the housing, a filter element (11) held in the housing (10) and comprising a filter medium (34) of water wettable material having a central passage extending between first and second ends of the filter medium (34), the first end of the filter medium being embedded in a first end cap (35) of a plastics material to close said passage and the second end of the filter medium being embedded in a second end cap (36) of a plastics material, said second end cap (36) providing a fluid connection between said passage and one of said ports (16,31), the first and second end caps (35,36) forming respective water-wettable joints with the filter medium (34).

20

2. A filter assembly according to claim 1, wherein said embedding involves heating the end caps (35,36) to soften the end caps and inserting each one of said first and second ends into the associated end cap (35,36) while the associated end cap (35,36) is softened.

3. A filter assembly according to claim 2, wherein said first and second end cap plastics material is such that the characteristics of the filter medium (34) adjacent to the end caps are not altered by said embedding.

4. A filter assembly according to ^{claim 1} ~~any one of claims 1 to 3~~, wherein the filter medium (34) is composed principally of PVDF which has been modified to make the medium water-wettable, and the first and second end caps (35,36) are composed of polypropylene.

5. A filter assembly according to ^{claim 1} ~~any one of claims 1 to 3~~, wherein the filter medium (34) is composed principally of polysulphone which has been modified to make the medium water-wettable, and the first and second end caps (35,36) are composed of polypropylene.

6. A filter assembly according to ^{claim 1} ~~any one of claims 1 to 3~~, wherein the filter medium (34) is a FLUORODYNE or SUPOR medium and the first and second end caps 35,36 are composed of polypropylene.

7. A filter assembly according to ^{claim 1} ~~any one of claims 1 to 3~~, wherein the filter medium (34) is composed of a nylon

material and the first and second end caps (35,36) are composed of a polyester or a nylon material.

8. A filter assembly according to ^{claim 1} ~~any preceding claim~~ wherein the filter element (34) is integrity testable by the Diffusive Forward Flow Test or by the Water Bubble Point Test.

9. A filter assembly according to claim 2 ~~or claim 3~~, wherein the plastics material of the first and second end caps (35,36) can be softened at a temperature which is sufficiently low such that the integrity of the filter medium (34) is undamaged when the filter medium (35,36) is inserted into the first and second end caps (35,36) when the first and second end caps (35,36) are at said temperature.

10. A filter assembly according to claim 9, wherein the filter medium (34) is hydrophobic.

11. A filter assembly according to claim 10, wherein the filter medium (34) is composed of PTFE and the first and second end caps (35,36) are composed of polypropylene.

12. A filter assembly according to claim 10, wherein the filter medium (34) is composed of PVDF and the first and second end caps (35,36) are composed of polypropylene.

B
13. A filter assembly according to ^{claim 1} ~~any preceding claim~~,
wherein the housing (10) resists exposure of the interior of
the housing (10) to steam at about 121°C and about 1 bar above
atmospheric pressure while the exterior of the housing (10) is
5 exposed to atmospheric pressure.

B
14. A filter assembly according to ^{claim 1} ~~any preceding claim~~,
wherein plastics material of the housing (10) is one of
polysulphone, PEEK, PEK, polyphenyleneoxide,
polyphenylenesulphide, polyethersulphone, polyalkoxysulphone
10 or polyarylsulphone.

B
15. A filter assembly according to ^{claim 1} ~~any preceding claim~~,
wherein said filter medium (34) is generally annular, the
first end cap (35) being generally disc-shaped and the second
end cap (36) being generally annular with a central aperture
15 for connection to one of said ports (16,31) of the housing.

20 16. A filter assembly according to claim 15, wherein the
filter medium (34) is pleated.

B
17. A filter assembly according to claim 15 ~~or claim 16~~,
wherein the second end cap (31) includes a projection (39)
defining a fluid path, said projection (39) being received in

the associated port (16,31) to provide fluid communication therebetween.

5 *sub C*
18. A filter assembly according to claim 17, wherein said housing (10) includes first and second opposed end walls (15,28), said housing port (31) in fluid communication with the second end cap (31) being formed in said second end wall (28), the filter element extending from said second end wall (28) towards said first end wall (15).

10
15
19. A filter assembly according to claim 18, wherein the housing (10) has a side wall (17) of generally circular cross-section extending between said first and second end walls (15,28).

B
20. A filter assembly according to ^{claim 1} ~~any preceding claim~~, wherein the housing (10) is formed by first and second housing parts (13,14) connected together.

SUB B'
20
21. A filter assembly according to claim 20 when dependent on claim 19, wherein the first housing part (13,14) includes said first end wall (15) and said side wall (17) and the second housing part (14) includes said second end wall (28).

B
5 22. A filter assembly according to claim 20 ~~or claim 21~~, wherein the first housing part (13) and the second housing part (14) co-operate to clamp the filter element (11) between said housing parts (13,14) to hold the filter element in the housing.

10 23. A filter element according to claim 22, wherein the filter element (11) includes first and second oppositely facing clamping surfaces, the first housing part (13) bearing against the first clamping surface and the second housing part (14) bearing against the second clamping surface.

15 24. A filter element according to claim 23, wherein said first and second clamping surfaces are formed on said second end cap (31).

20 25. A filter element according to claim 24, wherein the first clamping surface is formed on at least one flange (42) projecting from said second end cap (31).

SUB B2
25 26. A filter assembly according to claim 24 or claim 25, when dependent on claim 18, wherein said second clamping surface is formed on a portion of said second end cap (31) extending around said projection (34).

B
5
27. A filter assembly according to claim 25 ~~and claim 26~~ wherein said first housing part (13) has a peripheral edge (18) remote from said first end wall (15), said peripheral edge (18) bearing against said at least one flange (42) to force the second clamping surface against a portion of the second end wall (28) of the housing (10) around the associated port (31).

B
10
28. A filter assembly according to ^{claim 1} ~~any preceding claim~~, wherein the filter medium (34) is annular and has a curved exterior surface surrounded by a cage (37).

15
29. A filter assembly according to claim 28 wherein the cage (37) is formed from the same material as the end caps (35,36).

B
20
30. A filter assembly according to ^{claim 1} ~~any preceding claim~~, wherein the housing (10) is provided with at least one valve (12) that is manually operable to open and close the valve, the valve when open providing a fluid flow path between the exterior and the interior of the housing (10).

25
31. A filter assembly according to claim 30, wherein the or each said valve (12) is formed from materials that can be steam autoclaved.

32. A filter assembly according to claim 31, wherein the or each valve (12) is such that the assembly can be sterilized by subjecting the interior of the housing (10) to steam under pressure while the exterior of the housing (10) is at atmospheric pressure without damaging the valve (12).

33. A filter assembly according to claim 30, wherein the or each valve (12) is resistant to exposure of the interior of the housing to steam at about 121°C and about 1 bar above atmospheric pressure while the exterior of the housing is exposed to atmospheric pressure.

34. A filter assembly according to ^{claim 30} ~~any one of claims 30 to 33~~, wherein the or each said valve (12) is formed principally from one of polysulphone, PEEK, PEK, polyphenyleneoxide, polyphenylenesulphide, polyethersulphone polyalkoxysulphone or polyarylsulphone.

35. A filter assembly according to ^{claim 30} ~~any one of claims 30 to 35~~, wherein the or each valve (12) includes an annular sleeve (49) surrounding a passage (48) generally circular in cross-section, movement of said annular sleeve (49) in one sense opening said valve and movement of the annular sleeve (49) in a sense opposite said one sense closing said valve (12).

36. A filter assembly according to claim 35, wherein the or each passage (48) contains a valve member (43), movement of the associated sleeve (49) causing said valve member (43) to move between a first position in which said valve member (43) permits flow through said passage (48) and a second position in which said valve member (43) prevents flow through said passage (48).

37. A filter assembly according to claim 36, wherein the or each valve member (43) moves axially relative to the associated passage (48) between said first and second positions.

38. A filter assembly according to claim 37, wherein the sleeve (49) and the valve member (43) of the or each valve (12) are connected together, the sleeve (49) surrounding said associated passage (46) and the valve member (43) extending into an end of said passage (48), said valve member (43) including a passage (48) which is in fluid communication with the associated passage (46) when the valve (12) is open and which is not in fluid communication when the valve (12) is closed.

39. A filter assembly according to ^{claim 35} ~~any one of claims 35 to 38~~, wherein, for the or each valve (12), a mechanism acts

between the sleeve (49) and the housing (10) such that rotation of the sleeve (49) results in axial movement of said valve member (43) between said first and second positions.

5 40. A filter assembly according to claim 39, wherein the or each mechanism limits the extent of the axial movement of the associated valve member (43).

10 41. A filter assembly according to claim 39 ~~or claim 40~~ wherein the or each mechanism comprises a pin (27) and a co-operating slot (51).

15 42. A filter assembly according to claim 41 wherein the or each pin (27) is carried on an exterior surface of the housing (10) and the associated slot (51) extends helically partially around the sleeve (49).

20 43. A filter assembly comprising a housing (10) having an inlet port (16) and an outlet port (31) and a filter element (11) that is integrity testable by the Diffusive Forward Flow Test or the Water Bubble Point Test, that is held in the housing (10) and that comprises a filter medium (34) having a central passage extending between the first and second ends of the filter medium (34), the housing (10) being formed from a plastics material that is steam sterilizable.

25

44. A filter assembly according to claim 43, wherein the first end of the filter medium (34) is connected to a first end cap (35) to close said passage and the second end of the filter medium (34) is connected to a second end cap (36), said end caps (35,36) forming respective water-wettable joints with the filter medium.

45. A filter assembly according to claim 44, wherein the filter medium (34) is composed principally of PVDF which has been modified to make the medium water-wettable, and the end caps (35,36) are composed of polypropylene.

46. A filter assembly according to claim 44, wherein the filter medium (34) is composed principally of polysulphone which has been modified to make the medium water-wettable, and the end caps (35,36) are composed of polypropylene.

47. A filter assembly according to claim 44, wherein the filter medium (34) is a FLUORODYNE or SUPOR medium and the end caps (35,36) are composed of polypropylene.

48. A filter assembly according to claim 44, wherein the filter medium (34) is composed of a nylon material and the end caps (35,36) are composed of a polyester or a nylon material.

49. A filter assembly according to ^{claim 43} ~~any one of claims 43 to 48~~, wherein the housing (10) is such that the assembly can be sterilized by subjecting the interior of the housing (10) to steam under pressure while the exterior of the housing (10) is at atmospheric pressure without damaging the housing (10).

50. A filter assembly according to ^{claim 43} ~~any one of claims 43 to 48~~, wherein the housing (10) resists exposure of the interior of the housing (10) to steam at about 121°C and about 1 bar above atmospheric pressure while the exterior of the housing (10) is exposed to atmospheric pressure.

51. A filter assembly to ^{claim 43} ~~any one of claims 43 to 50~~, wherein the housing (10) is composed of any one of polysulphone, PEEK, PEK, polyphenyleneoxide, polyphenylene-sulphide, polyethersulphone, polyalkoxysulphone or polyarylsulphone.

52. A valve for a filter assembly comprising an annular sleeve (49) surrounding a passage (46) of generally circular cross-section, movement of said sleeve (49) in one sense opening said valve and movement of said sleeve (49) in a sense opposite said one sense closing said valve.

53. A valve according to claim 52, wherein said passage (48) contains a valve member (43), movement of said sleeve (49) causing said valve member (43) to move between a first position in which said valve member (43) permits flow through said passage (48) and a second position in which said valve member (43) prevents flow through said passage (48).

54. A valve according to claim 52, wherein said valve member (43) moves axially relative to said passage (48) between said first and second positions.

55. A valve according to claim 54, wherein the sleeve (49) and the valve member (43) are connected together, the sleeve (49) surrounding said passage (48) and the valve member (43) extending into an end of said passage (48), said valve member (43) including a passage (48) which is in fluid communication with the port passage (48) when the valve is open and which is not in fluid communication when the valve is closed.

56. A valve according to claim 54 ~~or claim 55~~, wherein a mechanism (27,51) acts between the sleeve (49) and the port such that rotation of the sleeve (49) results in axial movement of said valve member (43) between said first and second positions.

57. A valve according to claim 56, wherein said mechanism (27,51) limits the extent of the axial movement of the valve member (43).

B 5 58. A valve according to claim 56 ~~or claim 57~~, wherein said mechanism comprises a pin (27) and a co-operating slot (51).

SUB B3
10 59. A valve according to claim 58 when dependent on claim 55, wherein the pin (27) is carried on an exterior surface of the port and the slot (51) extends helically partially around the sleeve (49).

15 60. A valve comprising a part defining a cylindrical passage (48) and a valve member (43) movable between a first position in which the member (43) sits in and seals against the circumference of the passage (46) to close the valve and a second position in which the member (43) is located out of the passage (48) to open the valve.

20 61. A valve according to claim 60, wherein the valve member (43) is connected to the part by a mechanism (27,51) which causes the member (43) to enter the passage (46) to form said seal as the member is rotated relative to the part.

62. A valve according to claim 61, wherein the valve member (43) is connected to a sleeve (49) extending around the part and said mechanism (27,51) acts between the sleeve (49) and the part.

5
B 63. A valve according to claim 61 ~~or claim 62~~, wherein the part defines a chamber continuous with the passage (48), said valve member (43) lying in the chamber in said second portion.

10
64. A valve according to claim 63, wherein the part has a plurality of ribs (63,64) extending into said chamber, each rib having an edge leading to the circumference of the passage (46), said edges being spaced around the circumference of the passage (46), the valve member (43) carrying an O-ring (26) which forms said seal with the passage (46), the ribs (63,64) guiding the O-ring (26) into the passage on movement of the member into the first position.

15
20 65. A valve according to claim 67, wherein the valve member (43) moves on the axis of the passage (46).

25
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585
590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760
765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985
990
995

100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585
590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760
765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985
990
995

100
105
110
115
120
125
130
135
140
145
150
155
160
165
170
175
180
185
190
195
200
205
210
215
220
225
230
235
240
245
250
255
260
265
270
275
280
285
290
295
300
305
310
315
320
325
330
335
340
345
350
355
360
365
370
375
380
385
390
395
400
405
410
415
420
425
430
435
440
445
450
455
460
465
470
475
480
485
490
495
500
505
510
515
520
525
530
535
540
545
550
555
560
565
570
575
580
585
590
595
600
605
610
615
620
625
630
635
640
645
650
655
660
665
670
675
680
685
690
695
700
705
710
715
720
725
730
735
740
745
750
755
760
765
770
775
780
785
790
795
800
805
810
815
820
825
830
835
840
845
850
855
860
865
870
875
880
885
890
895
900
905
910
915
920
925
930
935
940
945
950
955
960
965
970
975
980
985
990
995